

Exercise Solutions for Math 20

Factoring Polynomials and Simplifying Rational Expressions

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1 Factor the following completely.

1.1 $16x^4 - 1$

$$\Rightarrow (4x^2 - 1)(4x^2 + 1)$$

Factor using difference of two squares.

$$\Rightarrow (2x - 1)(2x + 1)(4x^2 + 1)$$

Factor using difference of two squares.

■

1.2 $8j^3 - 125k^6$

$$\Rightarrow (2j - 5k^2)(4j^2 + 10jk^2 + 25k^4)$$

Factor using difference of two cubes.

■

1.3 $s^2 + 7s + 10$

$$\Rightarrow (s + 2)(s + 5)$$

Factor by grouping.

■

1.4 $4n^2 - 12n + 9$

$$\Rightarrow 4n^2 - 6n - 6n + 9$$

Factor by grouping.

$$\Rightarrow 2n(2n - 3) - 3(2n - 3)$$

$$\Rightarrow (2n - 3)^2$$

■

1.5 $x^3 - x^2 - x + 1$

$$\Rightarrow x^2(x - 1) - 1(x - 1)$$

Factor by grouping.

$$\Rightarrow (x^2 - 1)(x - 1)$$

$$\Rightarrow (x - 1)(x + 1)(x - 1)$$

Factor using difference of two squares.

$$\Rightarrow (x - 1)^2(x + 1)$$

■

1.6 $48 - 13q - q^2$

$$\Rightarrow -q^2 - 13q + 48$$

Rewrite in standard form.

$$\Rightarrow -(q^2 + 13q - 48)$$

$$\Rightarrow -(q - 3)(q + 16)$$

Factor by grouping.

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2 Reduce the following rational expressions to lowest terms.

2.1 $\frac{a^2-b^2}{a^3-b^3}$

$$\Rightarrow \frac{(a-b)(a+b)}{a^3-b^3}$$

Factor using difference of two squares.

$$\Rightarrow \frac{(a-b)(a+b)}{(a-b)(a^2+ab+b^2)}$$

Factor using difference of two cubes.

$$\Rightarrow \frac{a+b}{a^2+ab+b^2}$$

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2.2 $\frac{x^3-x^2y+xy^2-y^3}{x^6+y^6}$

$$\Rightarrow \frac{x^2(x-y)+y^2(x-y)}{x^6+y^6}$$

Factor by grouping.

$$\Rightarrow \frac{(x^2+y^2)(x-y)}{x^6+y^6}$$

$$\Rightarrow \frac{(x^2+y^2)(x-y)}{(x^2+y^2)(x^4-x^2y^2+y^4)}$$

Factor using difference of two cubes.

$$\Rightarrow \frac{x-y}{x^4-x^2y^2+y^4}$$

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3 Perform the following operations and simplify.

3.1 $\left(\frac{x}{x^2-1} - \frac{3}{x+1}\right) \div \frac{2x^2-x-3}{x^3-1}$

$$\begin{aligned}
 &\Rightarrow \left(\frac{x}{(x-1)(x+1)} - \frac{3}{x+1}\right) \div \frac{2x^2-x-3}{x^3-1} && \text{Factor using difference of two squares.} \\
 &\Rightarrow \left(\frac{x}{(x-1)(x+1)} - \frac{3(x-1)}{(x-1)(x+1)}\right) \div \frac{2x^2-x-3}{x^3-1} && \text{LCM} = (x-1)(x+1) \\
 &\Rightarrow \frac{x-3(x-1)}{(x-1)(x+1)} \div \frac{2x^2-x-3}{x^3-1} \\
 &\Rightarrow \frac{x-3x+3}{(x-1)(x+1)} \div \frac{2x^2-x-3}{x^3-1} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \div \frac{2x^2-x-3}{x^3-1} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \div \frac{2x^2+2x-3x-3}{x^3-1} && \text{Factor by grouping.} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \div \frac{2x(x+1)-3(x+1)}{x^3-1} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \div \frac{(2x-3)(x+1)}{x^3-1} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \div \frac{(2x-3)(x+1)}{(x-1)(x^2+x+1)} && \text{Factor using difference of two cubes.} \\
 &\Rightarrow \frac{-2x+3}{(x-1)(x+1)} \cdot \frac{(x-1)(x^2+x+1)}{(2x-3)(x+1)} && a \div b = a \cdot \frac{1}{b} \\
 &\Rightarrow \frac{(-2x+3)(x^2+x+1)}{(2x-3)(x+1)^2} \\
 &\Rightarrow \frac{-(2x-3)(x^2+x+1)}{(2x-3)(x+1)^2} \\
 &\Rightarrow -\frac{x^2+x+1}{(x+1)^2}
 \end{aligned}$$

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3.2 $\left(\frac{x}{x+y} + \frac{y}{x-y}\right) \cdot \frac{x^2-xy}{x^4-y^4} \div \frac{x}{x^2+2xy+y^2}$

$$\begin{aligned}
 &\Rightarrow \left(\frac{x(x-y)}{(x-y)(x+y)} + \frac{y(x+y)}{(x-y)(x+y)}\right) \cdot \frac{x^2-xy}{x^4-y^4} \div \frac{x}{x^2+2xy+y^2} && \text{LCM} = (x-y)(x+y) \\
 &\Rightarrow \frac{x(x-y)+y(x+y)}{(x-y)(x+y)} \cdot \frac{x^2-xy}{x^4-y^4} \div \frac{x}{x^2+2xy+y^2} \\
 &\Rightarrow \frac{x^2-xy+xy+y^2}{(x-y)(x+y)} \cdot \frac{x^2-xy}{x^4-y^4} \div \frac{x}{x^2+2xy+y^2} \\
 &\Rightarrow \frac{x^2+y^2}{(x-y)(x+y)} \cdot \frac{x^2-xy}{x^4-y^4} \div \frac{x}{x^2+2xy+y^2} \\
 &\Rightarrow \frac{x^2+y^2}{(x-y)(x+y)} \cdot \frac{x^2-xy}{(x^2-y^2)(x^2+y^2)} \div \frac{x}{x^2+2xy+y^2} && \text{Factor using difference of two squares.} \\
 &\Rightarrow \frac{x^2+y^2}{(x-y)(x+y)} \cdot \frac{x^2-xy}{(x-y)(x+y)(x^2+y^2)} \div \frac{x}{x^2+2xy+y^2} && \text{Factor using difference of two squares.} \\
 &\Rightarrow \frac{x^2+y^2}{(x-y)(x+y)} \cdot \frac{x(x-y)}{(x-y)(x+y)(x^2+y^2)} \div \frac{x}{x^2+2xy+y^2} \\
 &\Rightarrow \frac{x}{(x-y)(x+y)^2} \div \frac{x}{x^2+2xy+y^2} \\
 &\Rightarrow \frac{x}{(x-y)(x+y)^2} \div \frac{x}{(x+y)^2} && \text{Factor using perfect square trinomial.} \\
 &\Rightarrow \frac{x}{(x-y)(x+y)^2} \div \frac{(x+y)^2}{x} && a \div b = a \cdot \frac{1}{b} \\
 &\Rightarrow \frac{x}{(x-y)(x+y)^2} \cdot \frac{(x+y)^2}{x} \\
 &\Rightarrow \frac{1}{x-y}
 \end{aligned}$$

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3.3 $\frac{\frac{3}{p+q} + \frac{1}{p-2q}}{1 + \frac{p-q}{p-2q}}$

$$\Rightarrow \frac{\frac{3(p-2q)}{(p+q)(p-2q)} + \frac{p+q}{(p+q)(p-2q)}}{1 + \frac{p-q}{p-2q}}$$

$$\text{LCM} = (p+q)(p-2q)$$

$$\Rightarrow \frac{\frac{3(p-2q)+p+q}{(p+q)(p-2q)}}{1 + \frac{p-q}{p-2q}}$$

$$\Rightarrow \frac{\frac{4p-5q}{(p+q)(p-2q)}}{1 + \frac{p-q}{p-2q}}$$

$$\Rightarrow \frac{\frac{4p-5q}{(p+q)(p-2q)}}{\frac{p-2q}{p-2q} + \frac{p-q}{p-2q}}$$

$$\frac{a}{a} = 1$$

$$\Rightarrow \frac{\frac{4p-5q}{(p+q)(p-2q)}}{\frac{p-2q+p-q}{p-2q}}$$

$$\Rightarrow \frac{\frac{4p-5q}{(p+q)(p-2q)}}{\frac{2p-3q}{p-2q}}$$

$$\Rightarrow \frac{4p-5q}{(p+q)(p-2q)} \cdot \frac{p-2q}{2p-3q}$$

$$a \div b = a \cdot \frac{1}{b}$$

$$\Rightarrow \frac{4p-5q}{(p+q)(2p-3q)}$$

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